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1100 Seventeenth Street, N.W. Washington, D. C. 20036

SUBJECT: Voice Communications Requirements
and Criteria for AAP Missions 1
through 4. Case 620

DATE: November 15, 1968

FROM: A. G. Weygand

ABSTRACT

A preliminary draft of a document containing voice communications requirements and criteria for the Apollo Application Program (AAP) missions AAP-1 through AAP-4 is reviewed in this memorandum. This preliminary draft was generated by the Martin Marietta Corporation (MMC) in response to an action item assigned to MMC during the first meeting of the Ad Hoc Audio Working Group of the AAP Instrumentation and Communications Panel.

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REQUIREMENTS AND CRITERIA FOR AAP MISSIONS 1
THROUGH 4 (Bellcomm, Inc.) 14 p

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BELLCOMM, INC.

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WASHINGTON, D. C. 20024

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FROM: A. G. Weygand

MEMORANDUM FOR FILE

The writer reviewed a preliminary draft of a document distributed by Mr. A. E. Cole of the Martin Marietta Corporation (MMC) to various members of the Ad Hoc Audio Working Group of the Apollo Applications Program (AAP) Instrumentation and Communications (I/C) Panel in response to an action item to develop voice communications requirements and criteria for missions AAP-1 through AAP-4. This action item was assigned to MMC

during the first meeting of the working group.⁽¹⁾ A copy of this preliminary draft is included in this memorandum as Appendix A. It is the opinion of the writer that the content of this document should be restricted to cluster voice communications requirements and criteria. Therefore, it is recommended that the section of this document concerned with criteria for requirements and biomedical data gathering and handling in the AAP cluster and for the caution and warning system of the overall AAP cluster be deleted.

It is also recommended that the content of the cluster voice communications requirements and criteria section of this document be expanded to include the following items:

- (a) the requirements and criteria for both the baseline cluster mission and the backup Command Module/Service Module (CM/SM) and Lunar Module/Apollo Telescope Mount (LM/ATM) decoupled mission.
- (b) the requirements and criteria for voice communications support of crew members performing extravehicular activity (EVA) and intravehicular activity (IVA) as well as crew members in shirtsleave attire.
- (c) requirement for a communications intercom panel in the tunnel area of the CM.
- (d) requirement for provision of sidetone to a crew member except when using the speaker-microphone subsystem.

⁽¹⁾ A. G. Weygand, "Trip Report - First Meeting of the Ad Hoc Audio Working Group of the AAP I/C Panel", Memorandum for File, September 20, 1968.

- (e) requirement to permit a crew member whose voice annotations on experiments are being recorded to monitor the voice communications between the other two crew members and the MSFN.
- (f) requirement for provision of adequate displays to indicate to the crew members the specific voice communications channel which is being recorded.

In addition, some of the requirements and criteria contained in this draft document should be expanded for clarification and completeness. The results of an attempt by the writer to construct a consistent set of requirements and criteria for the design of a voice communications system for the AAP cluster is included in this memorandum as Appendix B. Every effort was made to phrase the criteria so that existing equipment design and hardware of the various modules would be used to the maximum extent practicable to meet the voice communications functional requirements.

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Attachments
Appendices A&B

APPENDIX A

The following criteria apply to the intercommunication system in all vehicle of the AAP Flights 1 through 4 unless limited in any specific criterion. The criteria are separated into three broad sections: voice, biomedical and caution and warning.

Section A: Voice & Voice Control and Display Functions

1. The intercommunication system shall be a hardwire system throughout all carriers (CSM, MDA, AM, WS and LM-A) in the cluster. This system shall provide two way (duplex) voice communication among astronauts.
2. The intercommunication system shall provide the means for duplex communication between astronauts in certain AAP carriers (MDA, AM, WS, and LM-A) and the stations of the Manned Space Flight Network (MSFN).
3. The intercommunication system shall use two of the three stations in the audio center of each AAP CSM (Flight 1, 3 and 3A) after docking to the Orbital Assembly (OA).
4. Two channels A and B of duplex audio service shall be carried across the space mated carrier interfaces (CSM/MDA and MDA/LM-A) with independent routings (separate and isolated connectors).
5. Connections to the intercommunication system shall be made at intercom panels distributed throughout the carriers of AAP Flights 1 through 4 in the following manner:
 - a. MDA (Docking port area) - 3
 - b. AM (Lock area) - 1
 - c. AM (STS area) - 2
 - d. WS (Crew Quarters area) - 6
 - e. WS (Forward LH₂ tank area) - 4
 - f. LM-A - 2
6. Each intercom panel shall have two identical connectors designated A and B. At each panel the capability to switch either of the connectors to the microphone input and headset output of either channel A or B shall be provided.

7. Either connector A or B shall accept the plug on the astronaut IVA or EVA umbilical.
8. Two astronauts may connect to connectors A and B of the same intercom panel simultaneously.
9. Microphone and headset lines in the OA shall have DC isolation from the CSM audio-center. Isolation provisions shall be located in the OA.
10. The external impedance presented to each CSM Audio Center by the channel A and B earphone lines shall not exceed the equivalent of two Apollo headsets.
11. Active components utilized to achieve line isolation shall be parallel redundant to each audio center.
12. Connections between the channel A microphone line and the channel B earphone line; and the channel B microphone line and the channel A earphone line, shall be accomplished by control switch settings on the two stations of the CSM audio center used to support the OA intercommunication system.
13. The capability for the astronaut to communicate with MSFN (via the CSM transmitter) through either channel from any intercom panel station shall be provided utilizing an extension of the push-to-transmit (PTX) circuit of the main line Apollo system. A two wire circuit shall be provided at each intercom panel interconnecting with a PTX switch located on the astronaut umbilical cable.
14. Either station of the CSM audio center shall be capable of being set up to respond to the PTX signal from the intercommunications system and provide communications to MSFN.
15. 28 VDC power shall be provided at each intercom panel. Each vehicle shall supply its own power to the intercom panel for this function.
16. The design of the intercom panel shall provide means to prevent arcing during mating and demating of the astronauts' umbilical.
17. Visual means shall be provided to indicate that DC power is available at the astronaut's umbilical.
18. Provisions shall be made such that any intercom panel may be used by an astronaut as a simplex (talk or listen) voice communication station without a headset. Microphone (talk) mode shall be available as push-to-talk

(momentary) and hands free (continuous). Speaker operation is not required simultaneously with either microphone mode.

19. Use of the intercom panel for a voice communication station without a headset shall provide an output level control on the speaker and an input sensitivity control on the microphone.
20. Control shall be provided at each intercom panel to "Enable" or "Inhibit" voice recording from the intercommunication system. Controls shall be momentary. "Enable" shall activate voice record electronics and start tape motion if required. "Inhibit" shall deactivate voice record channels, but not stop tape motion if it has been initiated from the AM control panel. "Enable" shall not be effective if recorder is in a playback mode.
21. An indicator light shall be provided on each intercom panel to show when voice recording has been enabled anywhere in the cluster.
22. Control and indication of the voice recording capability from the intercommunication system shall be provided in the CSM's used for AAP Flights 1, 3 and 3A. Functions shall be the same as those appearing on each intercom panel.
23. The capability of selecting the recording of voice from either channel A or channel B shall be provided in the AM.
24. The intercommunication headset shall be active in both the microphone (talk) and earphone (listen) mode when connected to an intercom panel connector supplying 28 VDC.
25. A level control for the headset earphones shall be provided as part of the headset or communications umbilical.
26. Electrical functions and mechanical elements common to all intercom panels in the MDA, AM, WS and LM-A shall utilize identical equipment and arrangements.

Section B: Biomedical

1. The intercommunications system shall provide for supporting the operational biomedical monitoring of two astronauts located in the MDA, AM, WS or LM-A.

2. The intercommunication system shall provide for transferring the following biomedical signals from connectors A and B on each intercom panel to a multiplexing system.

Connector A ECG Astronaut #1

 ZPN Astronaut #1

 Body Temperature Astronaut #1

Connector B ECG Astronaut #2

 ZPN Astronaut #2

 Body Temperature Astronaut #2

3. The intercommunication system shall provide for the transferring of astronaut identification signals from each connector to a multiplexing system. Signals shall be capable of identifying one of three astronauts.
4. The biomedical/communication harness shall provide the implementation of astronaut identification to be transferred through the intercommunication system.
5. Provisions shall be made for more than one astronaut utilizing a single channel (A or B) of the intercommunication system in the MDA, AM, WS and LM-A for voice while preserving the biomedical data and associated identification of one astronaut on the channel.
6. The intercommunication system shall distribute a nominal 16.8 VDC power source to all intercom connectors in the MDA, AM, WS and LM-A for powering the biomedical signal conditioners on the astronauts. This power shall be supplied from the AM for the baseline missions. For the backup CSM/LM-A mission the power shall be supplied by CSM.

Section C: Caution and Warning

1. Electrical signals in the audible frequency range for alerting astronauts to out-of-limit or mission critical conditions shall be originated in the CSM, AM and LM-A and distributed by the intercommunication system for electro-mechanical conversion by headset earphones and speakers.
2. The tones generated by the AM shall be distributed by the intercommunication system to all intercom panels in the MDA, AM and WS.

3. Tones shall not be carried across the space mated carrier interfaces (CSM/MDA and MDA/LM-A).
4. Tones shall not feed back across space mated carrier interfaces (CSM/MDA and MDA/LM-A) on earphone lines of the intercommunication system.
5. Tone signals shall be applied to the headset earphones and speakers in such a manner that the tones are unaffected by volume controls and signal defeat switches.
6. Each intercom panel shall have a momentary tone reset control. Activation of this control shall silence only the tone from the vehicle (AM, LM-A or CSM) supplying the panel where the reset is initiated.

APPENDIX B

Voice Communications System Requirements and Criteria for the AAP Cluster

1. The cluster voice communications subsystem shall provide the following capabilities regardless of the location of the crew members during either the baseline cluster mission or the backup LM/ATM mission:
 - a. private duplex voice intercom among the crew members
 - b. duplex voice communications among the crew members and the Manned Space Flight Network (MSFN)
 - c. recording of voice communications on-board the cluster and subsequent dump of the recorded audio to the MSFN
 - d. recording of voice annotations by one crew member independent of either concurrent private duplex voice intercom between the remaining crew members or concurrent duplex voice communications among the remaining crew members and the MSFN
2. A common voice communications hardline network shall be provided to interconnect:
 - a. crew members performing extravehicular activity (EVA), performing intravehicular activity (IVA), and/or at any work station in the MDA, AM and OWS and in the LM and CM when docked to the MDA during the baseline cluster mission
 - b. crew members performing EVA, IVA, and/or at any work station in the LM and CM when docked together during the backup LM/ATM mission
3. The common voice communications hardline network shall include redundant and independent voice communications hardlines which shall be routed in parallel but separated and using different connectors at module interfaces and shall be connected to different audio centers in the CM.
4. A different audio center of the CM shall provide the sole connection of the transmit and receive portions of each of the duplex voice communications hardlines thus forming two independent conference circuits.
5. Bridging of the redundant duplex voice communications hardlines together to form a single conference circuit shall be possible via switch settings at the audio centers of the CM at the discretion of a crew member in the CM.

6. Two electrical umbilical disconnects, one in each of the redundant voice communications hardlines, shall be provided on an intercom panel at each of the various work station locations in the MDA, AM, OWS, and LM.
7. The electrical umbilical disconnects shall be compatible with the umbilical connector of the personal communications systems of the crew members used during the performance of EVA or IVA or when in shirtsleeve attire.
8. Support for all required functions of the personal communications systems of the crew members (e.g., headset, microphone and amplifier, dc power, biomed, transmitter key, etc.) shall be available at each of these electrical umbilical disconnects.
9. Two crew members shall be able to plug the umbilical of their personal communications system into a different one of the two electrical umbilical disconnects at a given location and to use the respective voice communications hardlines simultaneously and without mutual interference.
10. Appearances of the dual electrical umbilical disconnects in the various modules of the cluster shall be as follows:
 - a. three (3) in the MDA.
 - b. one (1) in the airlock section of the AM
 - c. two (2) in the structural transition section of the AM
 - d. six (6) in the crew quarters area of the OWS
 - e. four (4) in the forward section of the OWS
 - f. two (2) in the LM
 - g. one (1) in the tunnel area of the CM
 - h. equivalent to one (1) in the CM (the third audio center)
11. One of the appearances of the dual electrical umbilical disconnects in the LM, the one appearance of the dual electrical umbilical disconnects in the tunnel area of the CM, and the appearance of the dual electrical umbilical disconnect in the airlock section of the AM shall be provided identically with the necessary oxygen and water coolant connectors, displays and controls required for support of up to two crew members performing EVA or IVA but need not be provided with any other displays, controls and/or switches.

12. Controls shall be provided at locations convenient to each of the appearances of the dual umbilical disconnects to enable two crewmen whose respective personal communications systems are plugged into a different one of the two disconnects to share both the transmit and receive portions of the same one of the two voice communications hardlines.
13. Controls shall be provided at locations convenient to each of the appearances of the dual electrical umbilical disconnects to enable a crew member whose personal communications system umbilical is plugged into one of the two disconnects to monitor with his headset the audio signals on both conference circuits when they are being operated independently.
14. Sidetone shall be provided to a crew member using one of the voice communications hardlines at any location in the cluster via the receive portion of the hardline from the audio center in CM.
15. All duplex voice communications between the cluster and the MSFN during either the baseline mission or the backup LM/ATM mission shall be provided via an RF link between the CM/SM and the MSFN:
 - a. the Unified S-Band (USB) system
 - b. the VHF/AM transceivers
 - c. the USB system and the VHF/AM transceivers simultaneously
16. An audio center of the CM/SM shall be used to interconnect one of the independent common voice communications hardlines (or the combined hardline) and the appropriate RF system(s) of the CM.
17. Selection by a crew member of the specific RF system(s) of the CM/SM and the specific voice communications hardline used to provide voice communications between the cluster and the MSFN shall only be possible from within the CM.
18. Crew members located in the CM, MDA, AM, OWS, or LM during the baseline mission or in the CM and LM in the backup LM/ATM mission shall be able to key the previously selected RF transmitter in the CM/SM by operating a push-to-transmit (PTX) switch from their remote location.
19. The umbilical of the personal communications system of the crew members shall be provided with:
 - a. a received voice volume control
 - b. a PTX switch which when operated shall key the CM/SM RF transmitter previously selected for transmission of voice signals to the MSFN

- c. a sleep switch which shall shut-off all transmitted or received voice signals while not affecting reception of tones generated by the Caution and Warning System (CWS) of the appropriate module
- 20. The microphone of the personal communications systems of the crew members shall operate either hot or push-to-talk (PTT).
 - 21. Simplex speaker-microphone intercom subsystems shall be provided for use in the CM, MDA, AM, OWS, and LM with the common voice communications hardline.
 - 22. When activated, the speaker-microphone intercom subsystem shall provide a hot speaker which shall be interrupted to provide the voice transmit function by crew member operation of a PTT or PTX switch.
 - 23. The speaker-microphone intercom subsystems shall be provided with the following controls:
 - a. an on-off switch
 - b. a received voice volume control
 - c. a transmitted voice gain control
 - d. a push-to-talk (PTT) switch which when operated shall deactivate the speaker and activate the microphone
 - e. a PTX switch which when operated shall deactivate the speaker, activate the microphone, and key the CM/SM RF transmitter previously selected for transmission of voice signals to the MSFN
 - f. a sleep switch which shall shut-off all received voice signals while not affecting reception of tones generated by the CWS of the appropriate module
 - 24. The speaker-microphone intercom subsystems shall be replaceable by the crew.
 - 25. To the maximum extent practicable, the controls and displays provided at each of the work stations in the cluster for monitoring and controlling the cluster voice communications system (exclusive of those stations used solely for EVA operations) shall be identical in both layout and operation.

26. The external loading of any of the CM audio centers shall not exceed the equivalent of two headsets of the type used in the personal communications systems used by the crew members.
27. An amplifier/isolation unit (audio load compensator) shall be included in each voice communications hardline for the baseline cluster mission only to provide the interface between the hardline and the audio center of the CM, provide dc isolation of the CM audio center from the hardline, provide automatically an essentially constant impedance to the CM audio center, and provide suitable audio signal levels.
28. The active portions of each amplifier/isolation unit shall be parallel redundant.
29. No amplifier/isolation units will be required for the backup LM/ATM mission.
30. Recording of the audio signals present on either one of the two independent voice communications hardlines shall be possible sequentially under crew control but not simultaneously.
31. Time correlation of recorded audio signals with mission events shall be provided.
32. During the baseline cluster mission, selected audio signals shall be recorded in the AM and dumped to the MSFN via an RF link from the AM.
33. The amplifier/isolation unit of each voice communications hardline shall provide a separate audio output suitable for recording of the voice signals present on the conference circuit.
34. During the backup LM/ATM mission, selected audio signals shall be recorded in the CM/SM and dumped to the MSFN via an RF link of the USB system of the CM/SM.
35. Controls shall be provided at locations convenient to each of the appearances of the dual electrical umbilical disconnects to enable the crew to:
 - a. inhibit recording of any voice signals present on either or both of the voice communications hardlines
 - b. activate a tape recorder for storing voice communications if none is operating

- c. record audio signals present on either one but not both of the voice communications hardline
 - d. select the particular voice communications hardline whose audio signals will be routed to a tape recorder for storage
36. Displays shall be provided at locations convenient to each of the appearances of the dual electrical umbilical disconnects to enable the crew member to establish:
- a. whether voice communications are being recorded
 - b. the specific voice communications hardline whose audio signals are being recorded
37. DC power provided at the electrical umbilical disconnects located in the MDA, AM, and OWS shall be supplied by the AM power system, in the LM by the LM/ATM power supply, and in the CM by the CM/SM power supply.
38. The electrical umbilical disconnects shall provide protection against possible arcing occurrence during mating or demating of the speaker-microphone intercom box and/or the umbilical of the personal communications system with the electrical umbilical disconnects.

Bellcomm, Inc.

Subject: Voice Communications Requirements and Criteria for AAP
Missions 1 through 4

From: A. G. Weygand

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